External DAQ, SVX sub-system notes.

Subrack specifications.

All eight SVX subrack modules and the subracks are built to VME standards developed by several organizations. The list of standards includes ANSI/VITA, VME and VME64 electrical specifications and the IEEE 1101.1 and 1101.10 mechanical specifications. Many safety and operations recommendations are made by these specifications.

Safety specifications.

The SVX Data Acquisition (DAQ) subracks and subrack modules are either commercially manufactured equipment or specialized components designed by the ESE department. Commercial equipment is certified to meet safety standards by the manufacturer. ESE department developed equipment has been designed to the subrack specifications above as detailed in the specifications for each module. The designs were examined by the Fermilab PPD printed circuit board certification panel.
The SiDet test stand hardware and power supplies are checked through an ESE process to ensure that they can be run unattended for periods including weekends and shutdowns.
The DAQ system is to be operated by or under the supervision of trained personnel. The list of operators currently is: Jean Slaughter, Mary Bishai, Steve Nahn, Steven Blusk, Bob Ely, Saverio D'Auria, and Gino Bolla.

Operation and procedures.

The operation of the external DAQ systems is normally controlled by the SVX DAQ software and that is controlled by the CDF DAQ software. DAQ operation under the SVX DAQ software is checked starting with a minimum of hardware connected to minimize the amount of equipment at risk. As the software is debugged and the confidence in it increases, more hardware is added. This process has been under way for some time at SiDet and FCC with no hardware damage related to software failures. At this time the DAQ system is considered to have a very low probability of causing hardware damage to detector or DAQ components.
There is a distinction between SIDet DAQ test stand operation and operation of the DAQ at Bzero. The operation procedures are very similar but the objectives are different. Bzero operation is aimed at testing the system as a whole while SiDet operation tends to be testing and characterizing components of the detector. The DAQ hardware at both sites will have to go through the same safety qualifications because both systems will need to be able to run attended. See below.
The procedures for DAQ operation at SiDet are at the URL XXXX. Only qualified operators of the DAQ system will be running the system.
The SIDet DAQ system itself has no interlocks and electrical protection is provided by fuses and over-voltage/over-current circuitry in the power supplies. For unattended operation, the VME subrack supplies will be interruptible by a local smoke detector.

ES&H Issues - Lasers

The DAQ system includes two different fiber optic telemetry systems that use laser light.

1. The SVX data comes from the detector to the FIB electronics on a parallel ribbon optical fiber system. The light is 1550-mm wavelength at less than 1 milliwatt of optical power. It is a closed link with special connectors, operated in areas that are not accessible by untrained operators so it not seen as a concern. The current operators list is: Jean Slaughter, Mary Bishai, Yuri Gotra, Steven Blusk, Bob Ely, Saverio D'Auria, Gino Bolla, Mao-Tung Cheng and Paul Chang.
2. Data is sent from the FIB electronics to the VRB electronics over a commercial fiber optic link manufactured by Finisar. It is a single fiber system operating at 850 mm at

approximately 1 milliwatt. These have very common ST style connectors and they will be more readily accessible both at SiDet and at Bzero in the first floor counting room. This is a closed system and the light level is below OSHA standards for Class two open systems. At SiDet, again, only trained operators will be changing these connections. However, at Bzero, it will be easy for an operator to open a link on the first floor without knowing if the transmitters are powered in the collision hall. For this reason, warning signs will be posted in the area of these connectors warning of the high light levels. See Appendix A, Laser safety analysis.

Unattended Operation

The DAQ system and the detector components connected to it are not interlocked or interdependent on each other. The detector components are protected by equipment described elsewhere. The DAQ will not become unsafe if the detector components are disabled. The detector safety, conversely, does not depend on the operation of the DAQ. Individual modules in the DAQ have power supply fuses that detect over current conditions and isolate the module. The subrack wiring is sized to match the maximum current available to the wire so that fuse operation is not hindered and wires cannot overheat. The subrack to power supply connections need to be covered prevent unintended connections by conductive objects. In the case of a massive subrack failure that could consume all of the power supply current, the power supply has foldback over current that reduces the available power to XX watts. The smoke detector will then detect this fault condition and disconnect the power supply mains.

Appendix A: SVX G-Link Systems Laser Safety Analysis

The SVX system uses fiber optic links to move data from the Fiber Interface Buffer in the collision hall up to VME Readout Buffers in the counting room area. These are the FTM-8510 series, Gigabit Optical Transmitters. ESE has been recording the light output of the Finisar G-Link transmitters. The recently received replacement modules have consistently higher light output levels than the original transmitters that had a mechanical alignment problem. The light levels are near a threshold within the OSHA safety guidelines for laser radiation. That realization triggered this analysis.

The Finisar modules emit near Infrared (IR) radiation at about 850 nm with an output power specified to be 0dBm maximum. 0-dBm light output is defined as 1 mw light output power. Finisar measures average RMS power encoding providing an average 50% duty cycle. We measured the light output with an optical to electrical probe and an oscilloscope so that we can measure the peak power and the on to off ratio. The modules we received in Sept-Oct occasionally exceeded 0dBm RMS power and some had peak readings near the 3-dBm level or 2 mw. OSHA Technical manual, section III chapter 6 says that this system is Class IIIA (1-5 mw) and that, at the 2.5 mw level, for open systems, posted warning signs must change from a Caution message to a Danger message.

The rules are convoluted because there are several mitigating factors at work here.

1. These data links fall under the Optical Fiber Communication Systems Service Group guidelines because, in normal use, the light is confined in the light-guide fiber-optic cables. SG designations have less stringent safety requirements because of the reduced exposure risk. This allows us to operate without warning signs and operator training. The main concern for SVX is the occasionally frequent situation under which the link is opened to service components. At those times, the risk of exposure increases significantly.
2. At first look, these lasers fall into Class IIIA in the Fermi safety manuals. However, this class can only include visible light lasers. This would force our links into Class IIIB with a significant change in required procedures and controls. However, the Fermi ES&H Manual excludes Optical Fiber Communication Systems and refers to the ANSI standard that OSHA uses.
3. The OSHA/ANSI define the Maximum Permissible Exposure (MPE) limits depending on light wavelength, intensity and exposure time. In the open system case, the wavelength is a problem because the light is not visible and does not cause a blink response but is close enough in wavelength to be nearly correctly focused by the eye. The intensity is high enough and concentrated enough to have some harmful effects on living tissue. In addition, the configuration of the modules and the subracks permits exposure to an operator's eyes and skin. Balancing this is the beam divergence, both at an open transmitter and from the end of an uncovered fiber such that you must be very close to the transmitter or fiber end to receive a dangerous exposure. In addition, the light is pulsed at approximately a 50% duty cycle.
4. The operator is not required to power down the data link while changing optical fiber connections. In normal operation, the subracks are separated such that the operator at the receiver end of a link may not know if the transmitter is operating.

Recommendations based on the above:

1. The G-Links are classified as OSHA OFCS SG3 and are safe under normal operating conditions. This laser class requires no warning signs or procedures.
2. The G-Link optical links are possible direct ocular hazards if operated as an open system with a fiber-optic cable disconnected from a transmitter or receiver.
3. The risk of hazardous exposure is extremely low because of the small distance required between the exposed tissue or eye and the light source. In addition, the exposure time required is more than twenty seconds.
4. None the less, experiment management should used best effort to inform operators who may need to make or break connections on this system as to the dangers involved. The VRB racks should be tagged with an ES&H label with the following caution.

CAUTION
DISCONNECTED OPTICAL CONNECTORS MAY EMIT OPTICAL RADIATION
DO NOT VIEW BEAM WITH OPTICAL INSTRUMENTS

Some Calculations

1 milliwatt = 1 dBm
Some of our transmitters produce peak powers of 2.7 dBm or 1.9 mw.
The duty cycle of 50% would reduce this exposure.
OSHA defines 1.9 milliwatt as the 10 second Maximum Permissible Exposure level for 840 nm laser light, therefore our light has approximately XXXXXXX MPE.
This indicates that the eye would need to be in contact with the laser or fiber to achieve the MPE.
The laser is in a connector shell, which does not permit contact with the laser device. The minimum separation is approximately 15 mm. The laser dispersion angle is 15 degrees, half angle. At 15 mm the 50 um laser light is reduced by a factor of XXXXX. {Calculation awaiting information from the manufacturer)

The transmitter output is specified for a 50-micrometer fiber, which we are using and this can be placed against the eye to achieve the 20-second MPE.
Any separation reduces the light intensity due to the dispersion angle of the fiber end.
The laboratory Laser Safety Officer suggested a 10-degree (conservatively assuming Full Width) angle of dispersion out of a terminated fiber end. At a 25 mm separation the cone of light would still fit within the 7 mm aperture of the eye but area spreading would reduce the light intensity by a factor of 1.3 ^10-4. The 1.9 mw/2 will be reduced to a level that is below the 30,000-second exposure limit. This work ignores any losses in the fiber or connectors, which would also reduce the light intensity.